



Five year cohort study of cardiac arrest management in general practice in Ireland.

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Five year cohort study of cardiac arrest management in general practice in Ireland.

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All authors have completed the Unified Competing Interest form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

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GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.



Article summary

Article focus

- Sudden Cardiac Death (SCD) is a leading cause of death in most countries; most events are due to ventricular fibrillation, caused by coronary artery disease. CPR and defibrillation are the key interventions in dealing with SCD but are critically time dependent.
- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland’s general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

Design

A five year prospective cohort study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period)

Setting

General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

Main outcome measures

Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

Results

36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.

Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65%, the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the courses of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

No additional data available.

Funding

Pre-Hospital Emergency care Council, Department of Health, Health Service Executive, Health Boards, Health Research Board provides support for purchase of equipment and training and for research components.

Contributorship

GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.

Competing Interests

None

Introduction

Ireland's population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health's Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports on the impact of general practitioner (GP) use of Advisory External Defibrillators (AEDs) and advanced life support provision in urban, rural and mixed areas of Ireland over a five year period.

Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x xi}; overall, a doubling of survival appears to result from early AED use. However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

Ireland has a well established general practice system delivered by 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-20011) for GP involvement in Cardiac Arrest with Resuscitation Attempts (CARA) in the community, with a specific focus on the experience of GPs in rural areas.

Materials and methods

2,600 GPs provide well-structured primary care in all areas of the country, organised in approximately 2,000 general practices; around one-third of Irish GPs work in single-handed practice^{xvi}. Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas. MERIT collected data from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices.

The MERIT (Medical Emergency Responders Integration and Training) Project was established in 2006 to enhance the care of emergencies in the community and is funded by the Pre-Hospital Emergency Care Council, the Health Service Executive, the Department of Health and Health Research Board. MERIT worked closely with the North West Immediate Care Programme which fulfils similar roles, is funded by the HSE Western Region and which supported defibrillator provision and training in that region. Many practices throughout the country have AEDs and staff members trained in basic and advanced life support; however, the MERIT Project offers standardised equipment, training, support and evaluation at national level which complements the work of individual practices.

MERIT provided AEDs and immediate care training to participating general practices throughout the country; individual practices were asked to categorise their location as urban, rural or a mixture of both types of locations. There are no standardised definitions in use for

urban, rural and mixed practice locations but typically urban locations indicate the major cities of Dublin, Limerick, Cork, Galway, Waterford and Sligo, rural locations are small towns or villages in isolated or remote communities and mixed locations involve towns with rural hinterlands.

All Cardiac Arrests with Resuscitation Attempts (CARAs) involving these practices are identified by quarterly survey; clinical and ECG data are collated with a mean response rate of 89% (81-97%) over the five year period. No patient identifying information was collected. A nurse researcher carried out a semi-structured interview with any GP whose practice reports a cardiac arrest in which GPs at the practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers. Missing data is reported (in tables below) in relation to cases where ascertainment of information could not be achieved; over the period, only partial outcomes data could be identified on ten cases. ECG downloads are collated from any MERIT AED used in the resuscitation and are reported separately.

PASW Statistics 18 was used for data analysis. Ethics permission was received from the Research Ethics Committee of the Irish College of General Practitioners.

Results

During the 60 month period 495 practices in the MERIT network were almost equally divided among 168 (33.9%) urban, 163 (32.9%) rural and 164 (33.1%) mixed sites. Cumulatively, AEDs were available for 27,084 AED months and were available for equivalent periods in each of the three areas: urban areas 9,108 AED months (33.6%), rural areas 9,252 AED months (34.2%) and mixed areas 8,724 AED months (32.2%).

Table 1 reports 272 CARAs and summarises data over the 60 month study period. In 45.2% of cases, the first AED on scene was brought by the GP; in 14.7% the first AED was brought by a first responder, usually a lay person. In 65% of cases, the GP was on duty at the time of the incident and in 169/257 (65.8%) cases was on the scene before the ambulance arrived.

Of all patients, 154 (58.6%) were in a shockable rhythm at some point, ROSC was achieved in 87 (32.0%) and 49 (18.7%) survived to hospital discharge.

Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

Table 2 summarises the involvement of general practices in CARAs, by region. Overall, 178 (36%) practices were involved in at least one event during the five year period; 66 (13.2%) were involved in more than one cardiac arrest and seven were involved in more than three incidents. It is striking that half of all rural practices were involved in at least one incident.

Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices are significantly

underrepresented having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

The location of the incident was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%), the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases.

There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP delivered first AED on scene (versus all other sources) in relation to hospital discharge (OR 1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xvii xviii}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xix}. The odds ratios calculated here report similar determinants of survival to other studies in the area; survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED.

Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest (OHCA) of 62/10⁵ person years, suggesting that Ireland experiences approximately 3,000 such events annually. In a 2009 editorial, Ewy proposed that survival from out-of-hospital cardiac arrest due to a shockable rhythm should

approach 40%; where it does not, improvements in health services protocols should be expedited^{xx}.

Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCA in their communities, a further improvement in early responses might be achieved.

All GPs in rural practice should be equipped with defibrillators. Links between rural general practice and Ambulance Service ‘first responder’ schemes may further improve effectiveness.

Table 1. Five year CARA data, 2007-2011.

	2007	2008	2009	2010	2011	Total
Cumulative AEDs	360	426	455	471	495	495
Urban	118	33	7	6	4	168 (33.9%)
Rural	128	11	4	5	15	163 (32.9%)
Mixed	114	22	18	5	5	164 (33.1%)
CARAs	55	63	64	48	42	272
Shockable rhythm	26	43	40	23	22	154/263 (58.6%)
ROSC	14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges	10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest	41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty	31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%
	Lay	8	10	15	5	2
						40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

		Urban	Rural	Mixed	Totals
CARAs		38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)		22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)		17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)		5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)		22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)	123 (45.2%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)	104 (38.2%)
	Lay	3	22	15	40 (14.7%)

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation
Title and abstract	1	(a) Five year cohort study of cardiac arrest management in general practice in Ireland (b) Abstract included
Introduction		
Background/rationale	2	Out-of-hospital cardiac arrest has a poor survival rate. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so. Little research has been published on the potential contribution of GPs to care for these emergencies.
Objectives	3	This study describes five year data (2007-2011) for GP involvement in Cardiac Arrest with Resuscitation Attempts (CARA) in the community, with a specific focus on the experience of GPs in rural areas.
Methods		
Study design	4	A five-year cohort study of Irish general practices reporting involvement in cardiac arrests with resuscitation attempts.
Setting	5	Between 2006 and 2012, MERIT supported AEDs and immediate care training at general practice sites in urban, rural and mixed areas throughout Ireland; 495 sites participated during the five years 2007-2011 and are included in this study.
Participants	6	(a) Practices in the MERIT network, reporting any cardiac arrest with a resuscitation attempt in which a GP had been involved. (b)
Variables	7	Date, time, location, participants, AED(s) available, clinical features, rhythms(s) identified, interventions, outcomes on scene, outcomes at 1 week (if known), ambulance response.
Data sources/measurement	8*	MERIT collected data from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices. All Cardiac Arrests with Resuscitation Attempts (CARAs) involving these GPs are identified by quarterly survey; clinical and ECG data are collated with a mean response rate of 89% (81-97%) over the five year period.
Bias	9	Structured debrief by research nurse; all ECG data is downloaded electronically from any MERIT AED used in the incident, printed and returned to the GP and used in the debrief.
Study size	10	Observational study of all cases, involving GPs from participating practices.
Quantitative variables	11	Standard clinical, organisational and outcomes items, used in resuscitation research.
Statistical methods	12	(a) PASW18 used for descriptive data and to calculate Odds Ratios (b) n/a (c) In 10 cases, survival to discharge could not be established. The altered denominators are reported in the relevant tables. (d) n/a (e) n/a
Results		
Participants	13*	(a) Participating GPs identified all cardiac arrests in which a resuscitation attempt occurred. (b) Response rates to quarterly data collection reported. (c) n/a

Descriptive data	14*	(a) Age, gender, location reported. Data reported for each year (2007-2011) and for urban, rural and mixed areas. (b) Discharge data missing for 10 patients, denominator amended. These data are missing because individual collapsed patients are not always known to the GP involved and may not be identifiable at follow-up. (c) Discharge alive from hospital
Outcome data	15*	Return of Spontaneous Circulation (ROSC) and survival to discharge from hospital.
Main results	16	ROSC and discharge rates reported. Odds ratios indicate survival in rural/mixed areas combined no different to survival in urban areas. Data for urban, rural, mixed areas reported in detail. Incidence rates per months of AED availability reported
Other analyses	17	n/a
Discussion		
Key results	18	Overall survival compares well with relevant literature. Little data from general practice for comparison. General practice contributes significantly to cardiac arrest management and has significant impact in rural and mixed areas.
Limitations	19	Cases may not be reported by participating GPs and retrospective semi-structured interview follow-up is subject to memory bias.
Interpretation	20	GPs may play a significant role in cardiac arrest management in the community.
Generalisability	21	The results relate to similar health systems with widely available primary care practitioners.
Other information		
Funding	22	Funding sources were the Health Service Executive (HSE), Pre-Hospital Emergency Care Council, Health Research Board and individual Health Boards prior to the the full establishment of the HSE.

*Give information separately for exposed and unexposed groups.



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review only

Article summary

Article focus

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- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland’s general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

Design

A five year prospective cohort study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period).

Setting

General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

Main outcome measures

Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

Results

36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.

Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65% the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the courses of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

There is no additional data available.

For peer review only

Introduction

Ireland's population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health's Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports incidence and outcomes data for general practitioner (GP) involvement in Cardiac Arrest with Resuscitation Attempt (CARA) in urban, rural and mixed areas of Ireland over a five year period. Clinical data on use of specific clinical interventions (e.g. advanced life support measures) and ECG data will be reported separately. A CARA is a cardiac arrest in which GPs at the reporting practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x}; overall, a doubling of survival appears to result from early Advisory External Defibrillator (AED) use^{xi}. However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

Ireland has a well established general practice system delivered by around 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-2011) for GP involvement in CARA in the community, with a specific focus on the experience of GPs in rural areas.

Materials and methods

Around 2,600 GPs provide well-structured primary care in all areas of the country, organised in approximately 2,000 general practices; around one-third of Irish GPs work in single-handed practice^{xvi}.

The MERIT (Medical Emergency Responders Integration and Training) Project was established in 2006 to enhance the care of emergencies in the community. In 2006 and 2007, all 2,347 GPs then identifiable in Ireland were contacted by letter and invited to join MERIT; 1,361 (58%) indicated interest, representing 811 centres of practice. Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas, based on a 'first come first served' approach. This study describes data collected by MERIT from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices.

This is a prospective cohort study. As practices joined MERIT, they were immediately enrolled in the data collection process for all CARAs. Each quarter, a questionnaire survey is sent to the lead GP for the practice, asking whether or not a CARA had occurred in the previous three months; returns of these questionnaires over the five year period ranged from

81% to 97% of participating practices in each quarter, averaging 89%. These returns also confirmed that practices had not experienced CARAs in the reporting period. Practices could report CARAs when they occurred – cross referencing ensured that no duplicates were reported in the quarterly survey. The key outcome measures are the incidence of CARAs, return of spontaneous circulation (ROSC) and discharge alive from hospital.

When CARAs were reported, a nurse researcher carried out a structured interview with the GP, using a modified Utstein template including location, known patient of the practice, demographic data, times, interventions, rhythms identified, participating services, ROSC on scene or later, discharge from hospital and source of AEDs used.

The number of months in which a practice participated in MERIT during the 60 month study period constituted ‘AED months’ and was calculated for each practice.

During the study period, the National Ambulance Service had no structured arrangements to notify GPs of cardiac arrests locally or to call on their assistance. Data was collected wherever possible on how the GP became aware of the CARA.

Recruitment to MERIT involved at least one GP from the practice participating in a standard one day Immediate Care Cardiac course, a skills based course covering Basic Life Support, AED use, standard pre-hospital Advanced Life Support protocols based on the Irish national Clinical Practice Guidelines^{xvii}, teamworking and work with the Ambulance Services. Participants are recommended to re-train regularly and at least on a two yearly basis.

MERIT is funded by the Pre-Hospital Emergency Care Council, the Health Service Executive, the Department of Health and Health Research Board. MERIT worked closely with the North West Immediate Care Programme which fulfils similar roles, is funded by the HSE Western Region and which supported defibrillator provision and training in that region. Many practices throughout the country have AEDs and staff members trained in basic and advanced life support; however, the MERIT Project offers standardised equipment, training, support and evaluation at national level which complements the work of individual practices.

Participating practices were asked to categorise their location as urban, rural or a mixture of both types of locations. There are no standardised definitions in use for urban, rural and mixed practice locations but typically urban locations indicate the major cities of Dublin, Limerick, Cork, Galway, Waterford and Sligo, rural locations are small towns or villages in isolated or remote communities and mixed locations involve towns with rural hinterlands.

No patient identifying information was collected. Missing data is reported (in text and tables below) in relation to cases where ascertainment of information could not be achieved; examples include the source of all AEDs used in cases or outcomes where the patient was unknown to the GP. Over the period, only partial data on outcomes were identified on ten cases. ECG downloads are collated from any MERIT AED used in the resuscitation and are reported separately.

PASW Statistics 18 was used for data analysis. Descriptive statistics are reported for cumulative data. Univariate analysis was carried out to calculate unadjusted odds ratios (p values, confidence intervals) for survival to discharge from hospital in relation to ROSC, witnessed collapse, rural versus other location, shock delivered and GP provided AED versus

AED from other source. Ethics permission was received from the Research Ethics Committee of the Irish College of General Practitioners.

Results

During the 60 month period 495 practices in the MERIT network were almost equally divided among 168 (33.9%) urban, 163 (32.9%) rural and 164 (33.1%) mixed sites. Cumulatively, AEDs were available for 27,084 AED months and were available for equivalent periods in each of the three areas: urban areas 9,108 AED months (33.6%), rural areas 9,252 AED months (34.2%) and mixed areas 8,724 AED months (32.2%).

Table 1 reports 272 CARAs and summarises data over the 60 month study period. In 45.2% of cases, the first AED on scene was brought by the GP; in 14.7% the first AED was brought by a first responder, usually a lay person. In 65% of cases, the GP was on duty at the time of the incident and in 169/257 (65.8%) cases was on the scene before the ambulance arrived.

Of all patients, 154 (58.6%) were in a shockable rhythm at some point, ROSC was achieved in 87 (32.0%) and 49 (18.7%) survived to hospital discharge.

Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

Table 2 summarises the involvement of general practices in CARAs, by region. Overall, 178 (36%) practices were involved in at least one event during the five year period; 66 (13.2%) were involved in more than one cardiac arrest and seven were involved in more than three incidents. It is striking that half of all rural practices were involved in at least one incident.

Tables 3 and 4 provide information on the relative involvement of practices in urban, rural or mixed locations, by AED months and numbers of CARAs reported.

Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data on CARAs by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices had fewer events having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

The place at which the CARA occurred was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%) cases, the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases. No incidents are known to have been generated from Ambulance Control. Virtually all CARAs in the practice or patient's home were initiated by the patient or a friend or family member making contact with the GP.

Figure 1 summarises recruitment and outcomes.

There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP provided first AED on scene (versus all other sources) in relation to hospital discharge (OR 1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. Henry et al recently reported an OHCA discharge rate of 7.4% in one Irish region and the Sudden Cardiac Death Task Force Report estimated discharge rates nationally to be around 5%^{v, vi}. At 19%, the discharge rates reported here suggest a subgroup of patients are being identified and managed by GPs, perhaps involving more arrests witnessed by GPs. In almost two-thirds of our cases, the GP was on scene before the arrival of the ambulance suggesting that local availability is an important factor.

AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xviii xix}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xx}. The odds ratios calculated here report similar determinants of survival to other studies in the area. The finding that survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED is noteworthy and needs further investigation. The study is not structured or powered to identify a statistical difference between GP provided AED in comparison to other sources but provides useful data to guide further hypothesis driven research to address this question.

Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest(OHCA) of $62/10^5$ person years, suggesting that Ireland experiences approximately 3,000 such events annually. In a 2009 editorial, Ewy proposed that survival from out-of-hospital-cardiac arrest due to a shockable rhythm should approach 40%; where it does not, improvements in health services protocols should be expedited^{xxi}. We believe this study indicates that general practice may have a role in contributing to this goal.

Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCA in their communities, a further improvement in early responses might be achieved.

All GPs in rural practice should be equipped with defibrillators. Links between rural general practice and Ambulance Service ‘first responder’ schemes may further improve effectiveness.

Table 1. Five year CARA data, 2007-2011.

		2007	2008	2009	2010	2011	Total
Cumulative AEDs		360	426	455	471	495	495
Urban		118	33	7	6	4	168 (33.9%)
Rural		128	11	4	5	15	163 (32.9%)
Mixed		114	22	18	5	5	164 (33.1%)
CARAs		55	63	64	48	42	272
Shockable rhythm		26	43	40	23	22	154/263 (58.6%)
ROSC		14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges		10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest		41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty		31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%	123 (45.2%)
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%	104 (38.2%)
	Lay	8	10	15	5	2	40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

		Urban	Rural	Mixed	Totals
CARAs		38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)		22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)		17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)		5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)		22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)	123 (45.2%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)	104 (38.2%)
	Lay	3	22	15	40 (14.7%)

Figure 1. Overview of recruitment and outcomes

2347	GPs identified in 2006/7 & invited to indicate interest (around 2000 centres of practice)
1361 (58%)	Indicated interest (811 centres of practice)
531	General practices enrolled 2006-2013
495	General practices enrolled 2006-2011 (reported here)
27,084	AED months of data collection
272	Cardiac Arrests with Resuscitation Attempts (CARAs)
262	CARAs with complete outcome data
154 (58.6%)	Shockable rhythms
87 (32.0%)	ROSC
49 (18.7%)	Discharge from hospital

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Five year cohort study of cardiac arrest management in general practice in Ireland.

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All authors have completed the Unified Competing Interest form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

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GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.



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Article summary

Article focus

- Sudden Cardiac Death (SCD) is a leading cause of death in most countries; most events are due to ventricular fibrillation, caused by coronary artery disease. CPR and defibrillation are the key interventions in dealing with SCD but are critically time dependent.
- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland's general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

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A five year prospective cohort study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period).

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General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

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Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

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36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.
Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65% the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the courses of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

There is no additional data available.

For peer review only

Introduction

Ireland’s population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health’s Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports incidence and outcomes data for general practitioner (GP) involvement in Cardiac Arrest with Resuscitation Attempt (CARA) on the impact of general practitioner (GP) use of Advisory External Defibrillators (AEDs) and advanced life support provision in urban, rural and mixed areas of Ireland over a five year period. Clinical data on use of specific clinical interventions (e.g. advanced life support measures) and ECG data will be reported separately. A CARA is a cardiac arrest in which GPs at the reporting practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

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Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x}. overall, a doubling of survival appears to result from early Advisory External Defibrillator (AED) use^{xi}. ~~overall, a doubling of survival appears to result from early AED use.~~ However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

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Ireland has a well established general practice system delivered by around 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-20011) for GP involvement in Cardiac Arrest with Resuscitation Attempts (CARA) in the community, with a specific focus on the experience of GPs in rural areas.

Materials and methods

Around 2,600 GPs provide well-structured primary care in all areas of the country, organised in approximately 2,000 general practices; around one-third of Irish GPs work in single-handed practice^{xvi}. ~~Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas. MERIT collected data from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices.~~

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The MERIT (Medical Emergency Responders Integration and Training) Project was established in 2006 to enhance the care of emergencies in the community. In 2006 and 2007, all 2,347 GPs then identifiable in Ireland were contacted by letter and invited to join MERIT. 1,361 (58%) indicated interest, representing approximately 811 GP centres of practice. Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas, based on a ‘first come first served’ approach.

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This study describes data collected by MERIT from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices. Over the following five year period, 531 units and training packages were provided to these practices and some newly identified ones.

This is a prospective cohort study. As practices joined MERIT, they were immediately enrolled in the data collection process for all CARAs. Each quarter, a questionnaire survey is sent to the lead GP for the practice, asking indicating whether or not a CARA had occurred in the previous three months; returns of these questionnaires over the five year period ranged from 81% to 97% of participating practices in each quarter, averaging 89%. There is therefore reasonable confidence that a very large proportion of CARAs were identified in these practices and that These returns also confirmed that practices which did not report CARAs had not actually experienced such events CARAs in the reporting period. Practices could also report CARAs directly when they occurred – cross referencing ensured that no duplicates were reported in the quarterly survey. The key outcome measures are the incidence of CARAs, return of spontaneous circulation (ROSC) and discharge alive from hospital.

When CARAs were reported, a nurse researcher carried out a structured interview with the GP, using a modified Utstein template including location, known patient of the practice, demographic data, times, interventions, rhythms identified, participating services, ROSC on scene or later, discharge from hospital and source of AEDs used.

The number of months in which a practice participated in MERIT during the 60 month study period constituted 'AED months' and was calculated for each practice.

During the study period, the National Ambulance Service had no structured arrangements to notify GPs of cardiac arrests locally or to call on their assistance. Data was collected wherever possible on how the GP became aware of the source of the CARA.

Recruitment to MERIT involved at least one GP from the practice participating in a standard one day Immediate Care Cardiac course, a skills based course covering Basic Life Support, AED use, standard pre-hospital Advanced Life Support protocols based on the Irish national Clinical Practice Guidelines^{xvii}, teamworking and work with the Ambulance Services. Participants are recommended to re-train regularly and at least on a two yearly basis.

A CARA is nurse researcher carried out a semi-structured interview with any GP whose practice reports a cardiac arrest in which GPs at the practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

MERIT^{and} is funded by the Pre-Hospital Emergency Care Council, the Health Service Executive, the Department of Health and Health Research Board. MERIT worked closely with the North West Immediate Care Programme which fulfils similar roles, is funded by the HSE Western Region and which supported defibrillator provision and training in that region. Many practices throughout the country have AEDs and staff members trained in basic and advanced life support; however, the MERIT Project offers standardised equipment, training, support and evaluation at national level which complements the work of individual practices.

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~~MERIT provided AEDs and immediate care training to participating general practices throughout the country; individual Participating~~ practices were asked to categorise their location as urban, rural or a mixture of both types of locations. There are no standardised definitions in use for urban, rural and mixed practice locations but typically urban locations indicate the major cities of Dublin, Limerick, Cork, Galway, Waterford and Sligo, rural locations are small towns or villages in isolated or remote communities and mixed locations involve towns with rural hinterlands.

~~All Cardiac Arrests with Resuscitation Attempts (CARAs) involving these practices are identified by quarterly survey; clinical and ECG data are collated with a mean response rate of 89% (81-97%) over the five year period. No patient identifying information was collected. A nurse researcher carried out a semi-structured interview with any GP whose practice reports a cardiac arrest in which GPs at the practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.~~ Missing data is reported (in [text and tables below](#)) in relation to cases where ascertainment of information could not be achieved; [examples include the source of all AEDs used in cases or outcomes where the patient was unknown to the GP.](#) ~~Over the period, only only-partial data on outcomes data were could be identified on ten cases.~~ ECG downloads are collated from any MERIT AED used in the resuscitation and are reported separately.

PASW Statistics 18 was used for data analysis. [Descriptive statistics are reported for cumulative data. Univariate analysis was carried out to calculate unadjusted odds ratios \(p values, confidence intervals\) for survival to discharge from hospital in relation to ROSC, witnessed collapse, rural versus other location, shock delivered and GP provided AED versus AED from other source.](#) Ethics permission was received from the Research Ethics Committee of the Irish College of General Practitioners. [Unadjusted Odd's Ratios are reported for](#)

Results

During the 60 month period 495 practices in the MERIT network were almost equally divided among 168 (33.9%) urban, 163 (32.9%) rural and 164 (33.1%) mixed sites. Cumulatively, AEDs were available for 27,084 AED months and were available for equivalent periods in each of the three areas: urban areas 9,108 AED months (33.6%), rural areas 9,252 AED months (34.2%) and mixed areas 8,724 AED months (32.2%).

Table 1 reports 272 CARAs and summarises data over the 60 month study period. In 45.2% of cases, the first AED on scene was brought by the GP; in 14.7% the first AED was brought by a first responder, usually a lay person. In 65% of cases, the GP was on duty at the time of the incident and in 169/257 (65.8%) cases was on the scene before the ambulance arrived.

Of all patients, 154 (58.6%) were in a shockable rhythm at some point, ROSC was achieved in 87 (32.0%) and 49 (18.7%) survived to hospital discharge.

Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

Table 2 summarises the involvement of general practices in CARAs, by region. Overall, 178 (36%) practices were involved in at least one event during the five year period; 66 (13.2%)

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were involved in more than one cardiac arrest and seven were involved in more than three incidents. It is striking that half of all rural practices were involved in at least one incident.

Tables 3 and 4 provide information on the relative involvement of practices in urban, rural or mixed locations, by AED months and numbers of CARAs reported.

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Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data on CARAs by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices had significantly fewer events are significantly underrepresented having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

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The place at which the CARA occurred location of the incident was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%) cases, the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases. No incidents are known to have been generated from Ambulance Control. Virtually all CARAs in the practice or patient's home were initiated by the patient or a friend or family member making contact with the GP.

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Figure 1 summarises recruitment and outcomes.

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There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP provided delivered first AED on scene (versus all other sources) in relation to hospital discharge (OR 1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. Henry et al recently reported an OHCA discharge rate of 7.4% in one Irish region and the Sudden Cardiac Death Task Force Report estimated discharge rates nationally to be around 5%^{v, vi}. At 19%, the discharge rates reported here suggest a subgroup of patients are being identified and managed by GPs, perhaps involving more arrests witnessed by GPs. In almost two-thirds of our cases, the GP was on scene before the arrival of the ambulance suggesting that local availability is an important factor.

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AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xviii xix}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xx}. The odds ratios calculated here report similar determinants of survival to other studies in the area.⁵ **The finding that survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED is noteworthy and needs further investigation. The study is not structured or powered to identify a statistical difference between GP provided AED in comparison to other sources but provides useful data to guide further hypothesis driven research to address this question.**

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Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest(OHCA) of 62/10⁵ person years, suggesting that Ireland experiences approximately 3,000 such events annually. In a 2009 editorial, Ewy proposed that survival from out-of-hospital-cardiac arrest due to a shockable rhythm should approach 40%; where it does not, improvements in health services protocols should be expedited^{xxi}. **We believe this study indicates that general practice may have a role in contributing to this goal.**

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Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those

11

communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCAs in their communities, a further improvement in early responses might be achieved.

All GPs in rural practice should be equipped with defibrillators. Links between rural general practice and Ambulance Service 'first responder' schemes may further improve effectiveness.

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Table 1. Five year CARA data, 2007-2011.

	2007	2008	2009	2010	2011	Total
Cumulative AEDs	360	426	455	471	495	495
Urban	118	33	7	6	4	168 (33.9%)
Rural	128	11	4	5	15	163 (32.9%)
Mixed	114	22	18	5	5	164 (33.1%)
CARAs	55	63	64	48	42	272
Shockable rhythm	26	43	40	23	22	154/263 (58.6%)
ROSC	14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges	10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest	41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty	31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%
	Lay	8	10	15	5	2
						40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

	Urban	Rural	Mixed	Totals
CARAs	38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)	22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)	17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)	5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)	22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)
	Lay	3	22	15
				40 (14.7%)

Figure 1. Overview of recruitment and outcomes

2347	GPs identified in 2006/7 & invited to indicate interest (around 2000 centres of practice)
1361 (58%)	Indicated interest (811 centres of practice)
531	General practices enrolled 2006-2013
495	General practices enrolled 2006-2011 (reported here)
27,084	AED months of data collection
272	Cardiac Arrests with Resuscitation Attempts (CARAs)
262	CARAs with complete outcome data
154 (58.6%)	Shockable rhythms
87 (32.0%)	ROSC
49 (18.7%)	Discharge from hospital

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation
Title and abstract	1	(a) Five year cohort study of cardiac arrest management in general practice in Ireland (b) Abstract included
Introduction		
Background/rationale	2	Out-of-hospital cardiac arrest has a poor survival rate. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so. Little research has been published on the potential contribution of GPs to care for these emergencies.
Objectives	3	This study describes five year data (2007-2011) for GP involvement in Cardiac Arrest with Resuscitation Attempts (CARA) in the community, with a specific focus on the experience of GPs in rural areas.
Methods		
Study design	4	A five-year cohort study of Irish general practices reporting involvement in cardiac arrests with resuscitation attempts.
Setting	5	Between 2006 and 2012, MERIT supported AEDs and immediate care training at general practice sites in urban, rural and mixed areas throughout Ireland; 495 sites participated during the five years 2007-2011 and are included in this study.
Participants	6	(a) Practices in the MERIT network, reporting any cardiac arrest with a resuscitation attempt in which a GP had been involved. (b)
Variables	7	Date, time, location, participants, AED(s) available, clinical features, rhythms(s) identified, interventions, outcomes on scene, outcomes at 1 week (if known), ambulance response.
Data sources/measurement	8*	MERIT collected data from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices. All Cardiac Arrests with Resuscitation Attempts (CARAs) involving these GPs are identified by quarterly survey; clinical and ECG data are collated with a mean response rate of 89% (81-97%) over the five year period.
Bias	9	Structured debrief by research nurse; all ECG data is downloaded electronically from any MERIT AED used in the incident, printed and returned to the GP and used in the debrief.
Study size	10	Observational study of all cases, involving GPs from participating practices.
Quantitative variables	11	Standard clinical, organisational and outcomes items, used in resuscitation research.
Statistical methods	12	(a) PASW18 used for descriptive data and to calculate Odds Ratios (b) n/a (c) In 10 cases, survival to discharge could not be established. The altered denominators are reported in the relevant tables. (d) n/a (e) n/a
Results		
Participants	13*	(a) Participating GPs identified all cardiac arrests in which a resuscitation attempt occurred. (b) Response rates to quarterly data collection reported. (c) n/a

Descriptive data	14*	(a) Age, gender, location reported. Data reported for each year (2007-2011) and for urban, rural and mixed areas. (b) Discharge data missing for 10 patients, denominator amended. These data are missing because individual collapsed patients are not always known to the GP involved and may not be identifiable at follow-up. (c) Discharge alive from hospital
Outcome data	15*	Return of Spontaneous Circulation (ROSC) and survival to discharge from hospital.
Main results	16	ROSC and discharge rates reported. Odds ratios indicate survival in rural/mixed areas combined no different to survival in urban areas. Data for urban, rural, mixed areas reported in detail. Incidence rates per months of AED availability reported
Other analyses	17	n/a
Discussion		
Key results	18	Overall survival compares well with relevant literature. Little data from general practice for comparison. General practice contributes significantly to cardiac arrest management and has significant impact in rural and mixed areas.
Limitations	19	Cases may not be reported by participating GPs and retrospective semi-structured interview follow-up is subject to memory bias.
Interpretation	20	GPs may play a significant role in cardiac arrest management in the community.
Generalisability	21	The results relate to similar health systems with widely available primary care practitioners.
Other information		
Funding	22	Funding sources were the Health Service Executive (HSE), Pre-Hospital Emergency Care Council, Health Research Board and individual Health Boards prior to the the full establishment of the HSE.

*Give information separately for exposed and unexposed groups.



**Five year cohort study of cardiac arrest management in
general practice in Ireland.**

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Five year cohort study of cardiac arrest management in general practice in Ireland.

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All authors have completed the Unified Competing Interest form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence on a worldwide basis to the BMJ Publishing Group Ltd and its Licensees to permit this article (if accepted) to be published in BMJ editions and any other BMJ PGL products and sublicences to exploit all subsidiary rights, as set out in our licence.

GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.



review only

Article summary

Article focus

- Sudden Cardiac Death (SCD) is a leading cause of death in most countries; most events are due to ventricular fibrillation, caused by coronary artery disease. CPR and defibrillation are the key interventions in dealing with SCD but are critically time dependent.
- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland's general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

Design

A five year prospective cohort study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period)

Setting

General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

Main outcome measures

Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

Results

36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.

Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65%, the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the course of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

There is no additional data available.

For peer review only

Introduction

Ireland's population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health's Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports incidence and outcomes data for general practitioner (GP) involvement in Cardiac Arrest with Resuscitation Attempt (CARA) in urban, rural and mixed areas of Ireland over a five year period. Clinical data on use of specific clinical interventions (e.g. advanced life support measures) and ECG data will be reported separately. A CARA is a cardiac arrest in which GPs at the reporting practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x}; overall, a doubling of survival appears to result from early Advisory External Defibrillator (AED) use^{xi}. However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

Ireland has a well established general practice system delivered by around 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-2011) for GP involvement in CARA in the community, with a specific focus on the experience of GPs in rural areas.

Materials and methods

Around 2,600 GPs provide well-structured primary care in all areas of the country, organised in approximately 2,000 general practices; around one-third of Irish GPs work in single-handed practice^{xvi}.

The MERIT (Medical Emergency Responders Integration and Training) Project was established in 2006 to enhance the care of emergencies in the community. In 2006 and 2007, all 2,347 GPs then identifiable in Ireland were contacted by letter and invited to join MERIT; 1,361 (58%) indicated interest, representing 811 centres of practice. Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas. This study describes data collected by MERIT from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices.

This is a prospective cohort study. As practices joined MERIT, they were immediately enrolled in the data collection process for all CARAs. Each quarter, a questionnaire survey is sent to the lead GP for the practice, asking whether or not a CARA had occurred in the previous three months; returns of these questionnaires over the five year period ranged from

81% to 97% of participating practices in each quarter, averaging 89%. These returns also confirmed that practices had not experienced CARAs in the reporting period. Practices could report CARAs when they occurred – cross referencing ensured that no duplicates were reported in the quarterly survey.

When CARAs were reported, a nurse researcher carried out a structured interview with the GP, using a modified Utstein template including location, known patient of the practice, demographic data, times, interventions, rhythms identified, participating services, ROSC on scene or later, discharge from hospital and source of AEDs used. The modifications addressed compliance with local ALS protocols, grades of Ambulance Service practitioners involved and the patient’s links with the practice.

The number of months in which a practice participated in MERIT during the 60 month study period constituted ‘AED months’ and was calculated for each practice.

During the study period, the National Ambulance Service had no structured arrangements to notify GPs of cardiac arrests locally or to call on their assistance. Data was collected wherever possible on the source of the CARA.

Recruitment to MERIT involved at least one GP from the practice participating in a standard one day Immediate Care Cardiac course, a skills based course covering Basic Life Support, AED use, standard pre-hospital Advanced Life Support protocols based on the Irish national Clinical Practice Guidelines^{xvii}, teamworking and work with the Ambulance Services. Participants are recommended to re-train regularly and at least on a two yearly basis.

MERIT is funded by the Pre-Hospital Emergency Care Council, the Health Service Executive, the Department of Health and Health Research Board. MERIT worked closely with the North West Immediate Care Programme which fulfils similar roles, is funded by the HSE Western Region and which supported defibrillator provision and training in that region. Many practices throughout the country have AEDs and staff members trained in basic and advanced life support; however, the MERIT Project offers standardised equipment, training, support and evaluation at national level which complements the work of individual practices.

Participating practices were asked to categorise their location as urban, rural or a mixture of both types of locations. There are no standardised definitions in use for urban, rural and mixed practice locations but typically urban locations indicate the major cities of Dublin, Limerick, Cork, Galway, Waterford and Sligo, rural locations are small towns or villages in isolated or remote communities and mixed locations involve towns with rural hinterlands.

No patient identifying information was collected. Missing data is reported (in text and tables below) in relation to cases where ascertainment of information could not be achieved; examples include the source of all AEDs used in cases or outcomes where the patient was unknown to the GP. Over the period, only partial data on outcomes were identified on ten cases. ECG downloads are collated from any MERIT AED used in the resuscitation and are reported separately.

PASW Statistics 18 was used for data analysis. Descriptive statistics are reported for cumulative data. Univariate analysis was carried out to calculate unadjusted odds ratios (p values, confidence intervals) for survival to discharge from hospital in relation to ROSC, witnessed collapse, rural versus other location, shock delivered and GP provided AED versus

AED from other source. Ethics permission was received from the Research Ethics Committee of the Irish College of General Practitioners.

Results

During the 60 month period 495 practices in the MERIT network were almost equally divided among 168 (33.9%) urban, 163 (32.9%) rural and 164 (33.1%) mixed sites. Cumulatively, AEDs were available for 27,084 AED months and were available for equivalent periods in each of the three areas: urban areas 9,108 AED months (33.6%), rural areas 9,252 AED months (34.2%) and mixed areas 8,724 AED months (32.2%).

Table 1 reports 272 CARAs and summarises data over the 60 month study period. In 45.2% of cases, the first AED on scene was brought by the GP; in 14.7% the first AED was brought by a first responder, usually a lay person. In 65% of cases, the GP was on duty at the time of the incident and in 169/257 (65.8%) cases was on the scene before the ambulance arrived.

Of all patients, 154 (58.6%) were in a shockable rhythm at some point, ROSC was achieved in 87 (32.0%) and 49 (18.7%) survived to hospital discharge.

Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

Table 2 summarises the involvement of general practices in CARAs, by region. Overall, 178 (36%) practices were involved in at least one event during the five year period; 66 (13.2%) were involved in more than one cardiac arrest and seven were involved in more than three incidents. It is striking that half of all rural practices were involved in at least one incident.

Tables 3 and 4 provide information on the relative involvement of practices in urban, rural or mixed locations, by AED months and numbers of CARAs reported.

Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data on CARAs by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices had significantly fewer events having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

The place at which the CARA occurred was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%) cases, the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases. No incidents are known to have been generated from Ambulance Control. Virtually all CARAs in the practice or patient's home were initiated by the patient or a friend or family member making contact with the GP.

There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed

collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP provided first AED on scene (versus all other sources) in relation to hospital discharge (OR1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. Henry et al recently reported an OHCA discharge rate of 7.4% in one Irish region and the Sudden Cardiac Death Task Force Report estimated discharge rates nationally to be around 5%^{v, vi}. At 19%, the discharge rates reported here suggest a subgroup of patients are being identified and managed by GPs, perhaps involving more arrest witnessed by GPs. In almost two-thirds of our cases, the GP was on scene before the arrival of the ambulance suggesting that local availability is an important factor.

AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xviiiix}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xx}. The odds ratios calculated here report similar determinants of survival to other studies in the area. The finding that survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED is noteworthy and needs further investigation. The study is not structured or powered to identify a statistical difference between GP provided AED in comparison to other sources but provides useful data to guide further hypothesis driven research to address this question.

Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest(OHCA) of 62/10⁵ person years, suggesting that Ireland experiences approximately 3,000 such events annually. In a 2009 editorial, Ewy

proposed that survival from out-of-hospital-cardiac arrest due to a shockable rhythm should approach 40%; where it does not, improvements in health services protocols should be expedited^{xxi}. We believe this study indicates that general practice may have a role in contributing to this goal, perhaps through mechanisms such as wider availability of AEDs and ALS training in general practice and closer links with the National Ambulance Service.

Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCAs in their communities, a further improvement in early responses might be achieved.

Table 1. Five year CARA data, 2007-2011.

		2007	2008	2009	2010	2011	Total
Cumulative AEDs		360	426	455	471	495	495
Urban		118	33	7	6	4	168 (33.9%)
Rural		128	11	4	5	15	163 (32.9%)
Mixed		114	22	18	5	5	164 (33.1%)
CARAs		55	63	64	48	42	272
Shockable rhythm		26	43	40	23	22	154/263 (58.6%)
ROSC		14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges		10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest		41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty		31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%	123 (45.2%)
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%	104 (38.2%)
	Lay	8	10	15	5	2	40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

	Urban	Rural	Mixed	Totals
CARAs	38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)	22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)	17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)	5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)	22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)
	Lay	3	22	15
				40 (14.7%)

Figure 1. Enrollment to MERIT

2347 GPs identified in 2006 & invited to indicate interest
(around 2000 centres of practice)

1361 (58%) indicated interest (811 centres of practice)

531 general practices enrolled 2006-2013

495 general practices enrolled 2006-2011 (reported here)

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Five year cohort study of cardiac arrest management in general practice in Ireland.

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The authors confirm they have no conflicts of interest in this research.

All authors have completed the Unified Competing Interest form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

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GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.



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Article summary

Article focus

- Sudden Cardiac Death (SCD) is a leading cause of death in most countries; most events are due to ventricular fibrillation, caused by coronary artery disease. CPR and defibrillation are the key interventions in dealing with SCD but are critically time dependent.
- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland’s general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

Design

A five year prospective cohort study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period)

Setting

General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

Main outcome measures

Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

Results

36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.

Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65%, the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the courses of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

There is no additional data available.

For peer review only

Introduction

Ireland's population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health's Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports incidence and outcomes data for general practitioner (GP) involvement in Cardiac Arrest with Resuscitation Attempt (CARA) in urban, rural and mixed areas of Ireland over a five year period. Clinical data on use of specific clinical interventions (e.g. advanced life support measures) and ECG data will be reported separately. A CARA is a cardiac arrest in which GPs at the reporting practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x}; overall, a doubling of survival appears to result from early Advisory External Defibrillator (AED) use^{xi}. However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

Ireland has a well established general practice system delivered by around 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-2011) for GP involvement in CARA in the community, with a specific focus on the experience of GPs in rural areas.

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The number of months in which a practice participated in MERIT during the 60 month study period constituted 'AED months' and was calculated for each practice.

During the study period, the National Ambulance Service had no structured arrangements to notify GPs of cardiac arrests locally or to call on their assistance. Data was collected wherever possible on the source of the CARA.

Recruitment to MERIT involved at least one GP from the practice participating in a standard one day Immediate Care Cardiac course, a skills based course covering Basic Life Support, AED use, standard pre-hospital Advanced Life Support protocols based on the Irish national Clinical Practice Guidelines^{xvii}, teamworking and work with the Ambulance Services. Participants are recommended to re-train regularly and at least on a two yearly basis.

MERIT is funded by the Pre-Hospital Emergency Care Council, the Health Service Executive, the Department of Health and Health Research Board. MERIT worked closely with the North West Immediate Care Programme which fulfils similar roles, is funded by the HSE Western Region and which supported defibrillator provision and training in that region. Many practices throughout the country have AEDs and staff members trained in basic and advanced life support; however, the MERIT Project offers standardised equipment, training, support and evaluation at national level which complements the work of individual practices.

Participating practices were asked to categorise their location as urban, rural or a mixture of both types of locations. There are no standardised definitions in use for urban, rural and mixed practice locations but typically urban locations indicate the major cities of Dublin, Limerick, Cork, Galway, Waterford and Sligo, rural locations are small towns or villages in isolated or remote communities and mixed locations involve towns with rural hinterlands.

No patient identifying information was collected. Missing data is reported (in text and tables below) in relation to cases where ascertainment of information could not be achieved; examples include the source of all AEDs used in cases or outcomes where the patient was unknown to the GP. Over the period, only partial data on outcomes were identified on ten cases. ECG downloads are collated from any MERIT AED used in the resuscitation and are reported separately.

PASW Statistics 18 was used for data analysis. Descriptive statistics are reported for cumulative data. Univariate analysis was carried out to calculate unadjusted odds ratios (p values, confidence intervals) for survival to discharge from hospital in relation to ROSC, witnessed collapse, rural versus other location, shock delivered and GP provided AED versus

AED from other source. Ethics permission was received from the Research Ethics Committee of the Irish College of General Practitioners.

Results

During the 60 month period 495 practices in the MERIT network were almost equally divided among 168 (33.9%) urban, 163 (32.9%) rural and 164 (33.1%) mixed sites. Cumulatively, AEDs were available for 27,084 AED months and were available for equivalent periods in each of the three areas: urban areas 9,108 AED months (33.6%), rural areas 9,252 AED months (34.2%) and mixed areas 8,724 AED months (32.2%).

Table 1 reports 272 CARAs and summarises data over the 60 month study period. In 45.2% of cases, the first AED on scene was brought by the GP; in 14.7% the first AED was brought by a first responder, usually a lay person. In 65% of cases, the GP was on duty at the time of the incident and in 169/257 (65.8%) cases was on the scene before the ambulance arrived.

Of all patients, 154 (58.6%) were in a shockable rhythm at some point, ROSC was achieved in 87 (32.0%) and 49 (18.7%) survived to hospital discharge.

Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

Table 2 summarises the involvement of general practices in CARAs, by region. Overall, 178 (36%) practices were involved in at least one event during the five year period; 66 (13.2%) were involved in more than one cardiac arrest and seven were involved in more than three incidents. It is striking that half of all rural practices were involved in at least one incident.

Tables 3 and 4 provide information on the relative involvement of practices in urban, rural or mixed locations, by AED months and numbers of CARAs reported.

Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data on CARAs by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices had significantly fewer events having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

The place at which the CARA occurred was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%) cases, the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases. No incidents are known to have been generated from Ambulance Control. Virtually all CARAs in the practice or patient's home were initiated by the patient or a friend or family member making contact with the GP.

There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed

collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP provided first AED on scene (versus all other sources) in relation to hospital discharge (OR1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. Henry et al recently reported an OHCA discharge rate of 7.4% in one Irish region and the Sudden Cardiac Death Task Force Report estimated discharge rates nationally to be around 5%^{v, vi}. At 19%, the discharge rates reported here suggest a subgroup of patients are being identified and managed by GPs, perhaps involving more arrest witnessed by GPs. In almost two-thirds of our cases, the GP was on scene before the arrival of the ambulance suggesting that local availability is an important factor.

AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xviiiix}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xx}. The odds ratios calculated here report similar determinants of survival to other studies in the area. The finding that survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED is noteworthy and needs further investigation. The study is not structured or powered to identify a statistical difference between GP provided AED in comparison to other sources but provides useful data to guide further hypothesis driven research to address this question.

Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest(OHCA) of 62/10⁵ person years, suggesting that Ireland experiences approximately 3,000 such events annually. In a 2009 editorial, Ewy

proposed that survival from out-of-hospital-cardiac arrest due to a shockable rhythm should approach 40%; where it does not, improvements in health services protocols should be expedited^{xxi}. We believe this study indicates that general practice may have a role in contributing to this goal, perhaps through mechanisms such as wider availability of AEDs and ALS training in general practice and closer links with the National Ambulance Service.

Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCAs in their communities, a further improvement in early responses might be achieved.

All GPs in rural practice should be equipped with defibrillators. Links between rural general practice and Ambulance Service 'first responder' schemes may further improve effectiveness.

Table 1. Five year CARA data, 2007-2011.

		2007	2008	2009	2010	2011	Total
Cumulative AEDs		360	426	455	471	495	495
Urban		118	33	7	6	4	168 (33.9%)
Rural		128	11	4	5	15	163 (32.9%)
Mixed		114	22	18	5	5	164 (33.1%)
CARAs		55	63	64	48	42	272
Shockable rhythm		26	43	40	23	22	154/263 (58.6%)
ROSC		14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges		10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest		41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty		31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%	123 (45.2%)
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%	104 (38.2%)
	Lay	8	10	15	5	2	40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

	Urban	Rural	Mixed	Totals
CARAs	38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)	22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)	17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)	5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)	22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)
	Lay	3	22	15
				40 (14.7%)

Figure 1. Enrollment to MERIT

2347 GPs identified in 2006 & invited to indicate interest
(around 2000 centres of practice)

1361 (58%) indicated interest (811 centres of practice)

531 general practices enrolled 2006-2013

495 general practices enrolled 2006-2011 (reported here)

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation
Title and abstract	1	(a) Five year cohort study of cardiac arrest management in general practice in Ireland (b) Abstract included
Introduction		
Background/rationale	2	Out-of-hospital cardiac arrest has a poor survival rate. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so. Little research has been published on the potential contribution of GPs to care for these emergencies.
Objectives	3	This study describes five year data (2007-2011) for GP involvement in Cardiac Arrest with Resuscitation Attempts (CARA) in the community, with a specific focus on the experience of GPs in rural areas.
Methods		
Study design	4	A five-year cohort study of Irish general practices reporting involvement in cardiac arrests with resuscitation attempts.
Setting	5	Between 2006 and 2012, MERIT supported AEDs and immediate care training at general practice sites in urban, rural and mixed areas throughout Ireland; 495 sites participated during the five years 2007-2011 and are included in this study.
Participants	6	(a) Practices in the MERIT network, reporting any cardiac arrest with a resuscitation attempt in which a GP had been involved. (b)
Variables	7	Date, time, location, participants, AED(s) available, clinical features, rhythms(s) identified, interventions, outcomes on scene, outcomes at 1 week (if known), ambulance response.
Data sources/measurement	8*	MERIT collected data from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices. All Cardiac Arrests with Resuscitation Attempts (CARAs) involving these GPs are identified by quarterly survey; clinical and ECG data are collated with a mean response rate of 89% (81-97%) over the five year period.
Bias	9	Structured debrief by research nurse; all ECG data is downloaded electronically from any MERIT AED used in the incident, printed and returned to the GP and used in the debrief.
Study size	10	Observational study of all cases, involving GPs from participating practices.
Quantitative variables	11	Standard clinical, organisational and outcomes items, used in resuscitation research.
Statistical methods	12	(a) PASW18 used for descriptive data and to calculate Odds Ratios (b) n/a (c) In 10 cases, survival to discharge could not be established. The altered denominators are reported in the relevant tables. (d) n/a (e) n/a
Results		
Participants	13*	(a) Participating GPs identified all cardiac arrests in which a resuscitation attempt occurred. (b) Response rates to quarterly data collection reported. (c) n/a

Descriptive data	14*	(a) Age, gender, location reported. Data reported for each year (2007-2011) and for urban, rural and mixed areas.
		(b) Discharge data missing for 10 patients, denominator amended. These data are missing because individual collapsed patients are not always known to the GP involved and may not be identifiable at follow-up.
		(c) Discharge alive from hospital
Outcome data	15*	Return of Spontaneous Circulation (ROSC) and survival to discharge from hospital.
Main results	16	ROSC and discharge rates reported. Odds ratios indicate survival in rural/mixed areas combined no different to survival in urban areas.
		Data for urban, rural, mixed areas reported in detail.
		Incidence rates per months of AED availability reported
Other analyses	17	n/a
Discussion		
Key results	18	Overall survival compares well with relevant literature. Little data from general practice for comparison. General practice contributes significantly to cardiac arrest management and has significant impact in rural and mixed areas.
Limitations	19	Cases may not be reported by participating GPs and retrospective semi-structured interview follow-up is subject to memory bias.
Interpretation	20	GPs may play a significant role in cardiac arrest management in the community.
Generalisability	21	The results relate to similar health systems with widely available primary care practitioners.
Other information		
Funding	22	Funding sources were the Health Service Executive (HSE), Pre-Hospital Emergency Care Council, Health Research Board and individual Health Boards prior to the the full establishment of the HSE.

*Give information separately for exposed and unexposed groups.



A five year study of cardiac arrest management in general practice in Ireland

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A five year study of cardiac arrest management in general practice in Ireland.

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The authors confirm they have no conflicts of interest in this research.

All authors have completed the Unified Competing Interest form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

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GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.



review only

Article summary

Article focus

- Sudden Cardiac Death (SCD) is a leading cause of death in most countries; most events are due to ventricular fibrillation, caused by coronary artery disease. CPR and defibrillation are the key interventions in dealing with SCD but are critically time dependent.
- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland's general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

Design

A five year prospective cross-sectional study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project, with data collection every three months over the five year period. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period)

Setting

General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

Main outcome measures

Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

Results

36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.

Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65%, the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the course of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

There is no additional data available.

For peer review only

Introduction

Ireland's population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health's Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports incidence and outcomes data for general practitioner (GP) involvement in Cardiac Arrest with Resuscitation Attempt (CARA) in urban, rural and mixed areas of Ireland over a five year period. Clinical data on use of specific clinical interventions (e.g. advanced life support measures) and ECG data will be reported separately. A CARA is a cardiac arrest in which GPs at the reporting practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x}; overall, a doubling of survival appears to result from early Advisory External Defibrillator (AED) use^{xi}. However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

Ireland has a well established general practice system delivered by around 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-2011) for GP involvement in CARA in the community, with a specific focus on the experience of GPs in rural areas.

Materials and methods

Around 2,600 GPs provide well-structured primary care in all areas of the country, organised in approximately 2,000 general practices; around one-third of Irish GPs work in single-handed practice^{xvi}.

The MERIT (Medical Emergency Responders Integration and Training) Project was established in 2006 to enhance the care of emergencies in the community. In 2006 and 2007, all 2,347 GPs then identifiable in Ireland were contacted by letter and invited to join MERIT; 1,361 (58%) indicated interest, representing 811 centres of practice. Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas. This study describes data collected by MERIT from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices.

This is a prospective cross-sectional study. As practices joined MERIT, they were immediately enrolled in the data collection process for all CARAs. Each quarter, a questionnaire survey is sent to the lead GP for the practice, asking whether or not a CARA had occurred in the previous three months; returns of these questionnaires over the five year

period ranged from 81% to 97% of participating practices in each quarter, averaging 89%. These returns also confirmed that practices had not experienced CARAs in the reporting period. Practices could report CARAs when they occurred – cross referencing ensured that no duplicates were reported in the quarterly survey.

When CARAs were reported, a nurse researcher carried out a structured interview with the GP, using a modified Utstein template including location, known patient of the practice, demographic data, times, interventions, rhythms identified, participating services, ROSC on scene or later, discharge from hospital and source of AEDs used. The modifications addressed compliance with local ALS protocols, grades of Ambulance Service practitioners involved and the patient’s links with the practice.

The number of months in which a practice participated in MERIT during the 60 month study period constituted ‘AED months’ and was calculated for each practice.

During the study period, the National Ambulance Service had no structured arrangements to notify GPs of cardiac arrests locally or to call on their assistance. Data was collected wherever possible on the source of the CARA.

Recruitment to MERIT involved at least one GP from the practice participating in a standard one day Immediate Care Cardiac course, a skills based course covering Basic Life Support, AED use, standard pre-hospital Advanced Life Support protocols based on the Irish national Clinical Practice Guidelines^{xvii}, teamworking and work with the Ambulance Services. Participants are recommended to re-train regularly and at least on a two yearly basis.

MERIT is funded by the Pre-Hospital Emergency Care Council, the Health Service Executive, the Department of Health and Health Research Board. MERIT worked closely with the North West Immediate Care Programme which fulfils similar roles, is funded by the HSE Western Region and which supported defibrillator provision and training in that region. Many practices throughout the country have AEDs and staff members trained in basic and advanced life support; however, the MERIT Project offers standardised equipment, training, support and evaluation at national level which complements the work of individual practices.

Participating practices were asked to categorise their location as urban, rural or a mixture of both types of locations. There are no standardised definitions in use for urban, rural and mixed practice locations but typically urban locations indicate the major cities of Dublin, Limerick, Cork, Galway, Waterford and Sligo, rural locations are small towns or villages in isolated or remote communities and mixed locations involve towns with rural hinterlands.

No patient identifying information was collected. Missing data is reported (in text and tables below) in relation to cases where ascertainment of information could not be achieved; examples include the source of all AEDs used in cases or outcomes where the patient was unknown to the GP. Over the period, only partial data on outcomes were identified on ten cases. ECG downloads are collated from any MERIT AED used in the resuscitation and are reported separately.

PASW Statistics 18 was used for data analysis. Descriptive statistics are reported for cumulative data. Univariate analysis was carried out to calculate unadjusted odds ratios (p values, confidence intervals) for survival to discharge from hospital in relation to ROSC, witnessed collapse, rural versus other location, shock delivered and GP provided AED versus

AED from other source. Ethics permission was received from the Research Ethics Committee of the Irish College of General Practitioners.

Results

During the 60 month period 495 practices in the MERIT network were almost equally divided among 168 (33.9%) urban, 163 (32.9%) rural and 164 (33.1%) mixed sites. Cumulatively, AEDs were available for 27,084 AED months and were available for equivalent periods in each of the three areas: urban areas 9,108 AED months (33.6%), rural areas 9,252 AED months (34.2%) and mixed areas 8,724 AED months (32.2%).

Table 1 reports 272 CARAs and summarises data over the 60 month study period. In 45.2% of cases, the first AED on scene was brought by the GP; in 14.7% the first AED was brought by a first responder, usually a lay person. In 65% of cases, the GP was on duty at the time of the incident and in 169/257 (65.8%) cases was on the scene before the ambulance arrived.

Of all patients, 154 (58.6%) were in a shockable rhythm at some point, ROSC was achieved in 87 (32.0%) and 49 (18.7%) survived to hospital discharge.

Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

Table 2 summarises the involvement of general practices in CARAs, by region. Overall, 178 (36%) practices were involved in at least one event during the five year period; 66 (13.2%) were involved in more than one cardiac arrest and seven were involved in more than three incidents. It is striking that half of all rural practices were involved in at least one incident.

Tables 3 and 4 provide information on the relative involvement of practices in urban, rural or mixed locations, by AED months and numbers of CARAs reported.

Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data on CARAs by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices had significantly fewer events having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

The place at which the CARA occurred was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%) cases, the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases. No incidents are known to have been generated from Ambulance Control. Virtually all CARAs in the practice or patient's home were initiated by the patient or a friend or family member making contact with the GP.

There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed

collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP provided first AED on scene (versus all other sources) in relation to hospital discharge (OR1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. Henry et al recently reported an OHCA discharge rate of 7.4% in one Irish region and the Sudden Cardiac Death Task Force Report estimated discharge rates nationally to be around 5%^{v, vi}. At 19%, the discharge rates reported here suggest a subgroup of patients are being identified and managed by GPs, perhaps involving more arrest witnessed by GPs. In almost two-thirds of our cases, the GP was on scene before the arrival of the ambulance suggesting that local availability is an important factor.

AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xviiiix}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xx}. The odds ratios calculated here report similar determinants of survival to other studies in the area. The finding that survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED is noteworthy and needs further investigation. The study is not structured or powered to identify a statistical difference between GP provided AED in comparison to other sources but provides useful data to guide further hypothesis driven research to address this question.

Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest(OHCA) of 62/10⁵ person years, suggesting that Ireland experiences approximately 3,000 such events annually^{xxi}. In a 2009 editorial, Ewy

proposed that survival from out-of-hospital-cardiac arrest due to a shockable rhythm should approach 40%; where it does not, improvements in health services protocols should be expedited^{xxii}. We believe this study indicates that general practice may have a role in contributing to this goal, perhaps through mechanisms such as wider availability of AEDs and ALS training in general practice and closer links with the National Ambulance Service.

Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCAs in their communities, a further improvement in early responses might be achieved.

Table 1. Five year CARA data, 2007-2011.

		2007	2008	2009	2010	2011	Total
Cumulative AEDs		360	426	455	471	495	495
Urban		118	33	7	6	4	168 (33.9%)
Rural		128	11	4	5	15	163 (32.9%)
Mixed		114	22	18	5	5	164 (33.1%)
CARAs		55	63	64	48	42	272
Shockable rhythm		26	43	40	23	22	154/263 (58.6%)
ROSC		14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges		10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest		41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty		31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%	123 (45.2%)
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%	104 (38.2%)
	Lay	8	10	15	5	2	40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

	Urban	Rural	Mixed	Totals
CARAs	38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)	22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)	17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)	5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)	22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)
	Lay	3	22	15
				40 (14.7%)

Figure 1. Enrollment to MERIT

2347 GPs identified in 2006 & invited to indicate interest
(around 2000 centres of practice)

1361 (58%) indicated interest (811 centres of practice)

531 general practices enrolled 2006-2013

495 general practices enrolled 2006-2011 (reported here)

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A five year ~~cohort~~ study of cardiac arrest management in general practice in Ireland.

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All authors have completed the Unified Competing Interest form and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work."

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GB is the Principal Investigator for the MERIT Project and has contributed to all components. MH and ME have designed and implemented all data collection, collation and analysis procedures. JD has contributed to design, data collection and practice support throughout the period. All authors have contributed to the preparation of the manuscript.



review only

Article summary

Article focus

- Sudden Cardiac Death (SCD) is a leading cause of death in most countries; most events are due to ventricular fibrillation, caused by coronary artery disease. CPR and defibrillation are the key interventions in dealing with SCD but are critically time dependent.
- General practitioners (GP) are well placed to deliver early care in many communities. However, the role of GPs in dealing with cardiac arrest in their communities has been little explored.
- 495 general practices joined this study over five years, to report all cardiac arrests in which GPs participated in care.

Key messages

- Of 272 cardiac arrests reported, the patient had a return of spontaneous circulation in 32% and was discharged from hospital in 18.7%; these survival rates are higher than those generally reported for out-of-hospital cardiac arrest. 49 patients survived cardiac arrest.
- 36% of practices reported a cardiac arrest during the period; 13% had more than one event. Rural practices experienced twice as many events as urban/mixed practices but had similar survival rates.
- In 45% of cases the first AED was brought by the GP and in 65% of cases the GP was on scene before the ambulance service.

Strengths and limitations

- The 495 participating practices (about a quarter of Ireland's general practices) contributed 27,000 months of defibrillator availability, with a mean 89% data collection rate.
- The duration, representativeness and good data collection rates of the study indicate that general practice has the potential to save additional lives in most communities.
- Caution is needed in generalising the experience of participating practices to all Irish practices and to other health care systems.

Abstract

Objective

To document the involvement of GPs in Cardiac Arrests with Resuscitation Attempts (CARAs) and to describe outcomes.

Design

A five year prospective ~~cohort~~ cross-sectional study of GPs in Ireland equipped with AEDs and immediate care training by the MERIT Project, with data collection every three months over the five year period. Practices reported CARAs by quarterly survey with 89% mean response rate (81-97% for the period)

Setting

General practices throughout Ireland.

Participants

495 general practices participated: 168 (33.9%) urban, 163 (32.9%) rural, 164 (33.1%) mixed.

Interventions

All participating practices received a standard AED and basic life support kit. Training in immediate care was provided for at least one GP in the practice.

Main outcome measures

Incidence of Cardiac Arrest with Resuscitation Attempt in participating practices.
Return of spontaneous circulation (ROSC) and discharge alive from hospital.

Results

36% of practices were involved in a CARA during the five year period and 13% were involved in more than one CARA.

Of 272 CARAs reported, ROSC occurred in 32% (87/272) and discharge from hospital in 18.7% (49/262). In 45% of cases, the first AED was brought by the GP and in 65%, the GP arrived before the ambulance service. More cases occurred in rural and mixed settings than urban ones but survival rates did not differ between areas. In 65% of cases, the GP was on duty at the time of the incident and 47% of cases occurred in the patient's home.

Conclusions

These outcomes are comparable with more highly structured components of the emergency response system and indicate that GPs have an important role to play in the care of patients in their own communities. GPs experience cardiac arrests during the course of their daily work and provide prompt care that results in successful outcomes in urban, mixed and rural settings.

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Data sharing statement

There is no additional data available.

For peer review only

Introduction

Ireland's population of 4.5m includes 38% who live in rural areasⁱ. Resuscitation outcomes from sudden cardiac death are traditionally poorer in rural areas^{ii iii iv}, although recent Irish regional data suggest comparable urban and rural outcomes in one region^v. The Department of Health's Report on Sudden Cardiac Death estimated survival rates from out-of-hospital cardiac arrest in Ireland at around 5%^{vi}.

This study reports incidence and outcomes data for general practitioner (GP) involvement in Cardiac Arrest with Resuscitation Attempt (CARA) in urban, rural and mixed areas of Ireland over a five year period. Clinical data on use of specific clinical interventions (e.g. advanced life support measures) and ECG data will be reported separately. A CARA is a cardiac arrest in which GPs at the reporting practice have contributed to the resuscitation effort, whether alone or in conjunction with ambulance staff or other healthcare providers.

Early response to out-of-hospital cardiac arrest is critical to resuscitation, but not always possible. Solutions proposed include Public Access Defibrillation, reduced EMS call-response intervals and first responder schemes^{vii viii ix x}; overall, a doubling of survival appears to result from early Advisory External Defibrillator (AED) use^{xi}. However, little research has explored the potential impact of GP delivered care in health care systems with well established general practice structures. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so^{xii xiii}. In 2009, initial data was reported from the MERIT Project in Ireland, indicating a discharge rate of 19.5% among 136 cardiac arrests managed by GPs^{xiv}.

Ireland has a well established general practice system delivered by around 2,600 GPs, with significant involvement in local emergencies^{xv}. This study describes five year data (2007-20011) for GP involvement in CARA in the community, with a specific focus on the experience of GPs in rural areas.

Materials and methods

Around 2,600 GPs provide well-structured primary care in all areas of the country, organised in approximately 2,000 general practices; around one-third of Irish GPs work in single-handed practice^{xvi}.

The MERIT (Medical Emergency Responders Integration and Training) Project was established in 2006 to enhance the care of emergencies in the community. In 2006 and 2007, all 2,347 GPs then identifiable in Ireland were contacted by letter and invited to join MERIT; 1,361 (58%) indicated interest, representing 811 centres of practice. Between 2006 and 2012, MERIT supported AEDs and immediate care training at 531 general practice sites in urban, rural and mixed areas. This study describes data collected by MERIT from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices.

This is a prospective ~~cohort~~ cross-sectional study. As practices joined MERIT, they were immediately enrolled in the data collection process for all CARAs. Each quarter, a questionnaire survey is sent to the lead GP for the practice, asking whether or not a CARA had occurred in the previous three months; returns of these questionnaires over the five year

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period ranged from 81% to 97% of participating practices in each quarter, averaging 89%. These returns also confirmed that practices had not experienced CARAs in the reporting period. Practices could report CARAs when they occurred – cross referencing ensured that no duplicates were reported in the quarterly survey.

When CARAs were reported, a nurse researcher carried out a structured interview with the GP, using a modified Utstein template including location, known patient of the practice, demographic data, times, interventions, rhythms identified, participating services, ROSC on scene or later, discharge from hospital and source of AEDs used. The modifications addressed compliance with local ALS protocols, grades of Ambulance Service practitioners involved and the patient’s links with the practice.

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Witnessed arrests averaged 78.2% (68.8-90.4% per year), 70.9% were male and median age was 60 (0-89); no significant changes occurred in these characteristics over the period.

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Tables 3 and 4 provide information on the relative involvement of practices in urban, rural or mixed locations, by AED months and numbers of CARAs reported.

Table 3 summarises the ratio of CARAs to months of AED availability, by region. Rural practices (1 CARA per 74 months) are three times more likely to be involved in cardiac arrest management than urban practices (1 CARA per 240 months).

Table 4 presents data on CARAs by urban, rural or mixed location. It is striking that in spite of near equivalent number of available AED months in each region, urban practices had significantly fewer events having participated in only 14% of all CARAs while rural practices contributed 46.3% and mixed practices 39.7%.

The place at which the CARA occurred was reported in 269 (98.9%) cases and was equivalent in urban, rural and mixed settings – CARA occurred in the GP's practice in 39 (14.4%) cases, the patient's home in 128 (47.1%) cases and other locations in 102 (37.9%) cases. No incidents are known to have been generated from Ambulance Control. Virtually all CARAs in the practice or patient's home were initiated by the patient or a friend or family member making contact with the GP.

There was no significant difference between survival to discharge rates in rural (17.1%) and non-rural (20.1%) settings (OR 0.9, 95% CI 0.7-1.2). Odds ratios were also calculated in relation to survival to hospital discharge for ROSC (OR 5.7, 95% CI 4.2-7.7), witnessed

collapse (OR 1.36, 95% CI 1.3-1.5), defibrillation shock delivered (OR 1.8, 95% CI 1.5-2.1), all of which indicate a positive contribution to survival. Odds ratios for GP provided first AED on scene (versus all other sources) in relation to hospital discharge (OR1.2, 95% CI 0.9-1.6) did not show an improvement.

A fall in the numbers of CARAs reported by GPs has occurred in 2011 since a peak in 2009, particularly in urban areas.

Discussion

This study is one of the first to provide systematic data on the experience of large numbers of GPs in the management of cardiac arrest in their communities. General practice involvement in CARAs in the community was sustained through the five year period of this study, with significant numbers of cases and successful outcomes. The outcomes of CARAs appear to be equivalent in urban, rural and mixed areas with a discharge rate from hospital of almost 19%, with an average of ten survivors reported annually. Henry et al recently reported an OHCA discharge rate of 7.4% in one Irish region and the Sudden Cardiac Death Task Force Report estimated discharge rates nationally to be around 5%^{v, vi}. At 19%, the discharge rates reported here suggest a subgroup of patients are being identified and managed by GPs, perhaps involving more arrest witnessed by GPs. In almost two-thirds of our cases, the GP was on scene before the arrival of the ambulance suggesting that local availability is an important factor.

AEDs in rural practices are three times more likely to be used for cardiac arrest management than those in urban practices and half of all AEDs in rural areas have been used to manage a cardiac arrest in the five year period.

In 45% of all cases (and half of all rural cases) the first AED on scene was brought by the GP involved, the GP was on scene before the ambulance in 65% of cases and in 58.6% of all cases the patient had a shockable rhythm. Interestingly, 4% of practices were involved in the management of three or more CARAs in the period. These data strongly indicate that GPs are available at an early point in the cardiac arrest and that GPs in rural communities are a key resource in the management of emergencies in their communities.

Recent studies have highlighted lower survival in OHCA events occurring in the home in comparison to those in public areas^{xviiiix}. In this study, almost half of all cases occurred in the patient's home. The involvement of GPs may offer a mechanism to address the reported disadvantage generated in at-home events. Lay responders contributed the initial AED on scene in 14% of cases, indicating a significant contribution to cardiac arrest management in the community^{xx}. The odds ratios calculated here report similar determinants of survival to other studies in the area. The finding that survival is not influenced by the GP bringing the AED used, when compared with all other sources of an AED is noteworthy and needs further investigation. The study is not structured or powered to identify a statistical difference between GP provided AED in comparison to other sources but provides useful data to guide further hypothesis driven research to address this question.

Berdowski et al have calculated a global mean incidence of Emergency Medical Services treated adult out-of-hospital cardiac arrest(OHCA) of 62/10⁵ person years, suggesting that Ireland experiences approximately 3,000 such events annually^{xxi}. In a 2009 editorial, Ewy

proposed that survival from out-of-hospital-cardiac arrest due to a shockable rhythm should approach 40%; where it does not, improvements in health services protocols should be expedited^{xxii}. We believe this study indicates that general practice may have a role in contributing to this goal, perhaps through mechanisms such as wider availability of AEDs and ALS training in general practice and closer links with the National Ambulance Service.

Our data show that MERIT GPs – around a quarter of Irish general practices – were involved in the active resuscitation of around 50 patients each year. Many Irish general practices outside the MERIT framework are also equipped with AEDs and may contribute to management of incidents in their practices or communities. Our data suggest that the potential exists for GP involvement in 200-250 out-of-hospital cardiac arrests annually, if all GPs in Ireland were similarly involved, representing around 8% of all events in the country. With additional active links to the emergency medical services, further improvements might be achieved. Such protocol changes have significant potential both in Ireland and in countries with other well established general practice systems.

Conclusions

Irish general practitioners encounter sudden cardiac death frequently, provide standardised care and have good outcomes. Most events occur within routine GP activities. These findings are similar in urban, rural and mixed areas but rural GPs are more likely to be called on in OHCA than their urban counterparts. If all GPs in rural areas were equipped with AEDs, a significant additional capacity for early resuscitation would be available to those communities. If arrangements were in place for Ambulance Service control centres to alert those GPs to OHCAs in their communities, a further improvement in early responses might be achieved.

Table 1. Five year CARA data, 2007-2011.

	2007	2008	2009	2010	2011	Total
Cumulative AEDs	360	426	455	471	495	495
Urban	118	33	7	6	4	168 (33.9%)
Rural	128	11	4	5	15	163 (32.9%)
Mixed	114	22	18	5	5	164 (33.1%)
CARAs	55	63	64	48	42	272
Shockable rhythm	26	43	40	23	22	154/263 (58.6%)
ROSC	14/55	22/63	25/64	12/48	14/42	87/272 (32.0%)
Discharges	10/53	12/61	14/60	5/47	8/41	49/262 (18.7%)
Witnessed arrest	41/54 75.9%	57/63 (90.4%)	50/64 (78.1%)	33/48 (68.8%)	31/42 (73.8%)	212/271 (78.2%)
GP on duty	31/53 (58.5%)	43/63 (68.3%)	41/64 (64%)	30/48 (62.5%)	30/41 (73.2%)	175/269 (65%)
Source of first AED n= 267	GP	32 58%	27 42.9%	21 32.8%	19 39.6%	24 57.1%
	Ambulance	15 27.3%	25 39.7%	26 40.6%	23 47.9%	15 35.7%
	Lay	8	10	15	5	2
						40 (14.7%)

Table 2. Practice involvement in a CARA, 2007-2011.

	Urban	Rural	Mixed	Totals
	168 (33.9%)	163* (32.9%)	164 (33.1%)	495
Not involved in a CARA	133 (78.6%)	83 (50.9%)	101 (61.6%)	317 (64%)
Involved in a CARA	35 (20.8%)	80 (49.1%)	63 (38.4%)	178 (36%)
CARAs x 1	28	49	35	112 (22.6%)
CARAs x 2	6	23	16	45 (9.0%)
CARAs x 3	1	4	9	14 (2.8%)
CARAs >3	0	4	3	7 (1.4%)

Table 3. Cara incidence / AED months

	Urban	Rural	Mixed	Overall
CARAs	38	126	108	272
AED months	9108	9252	8724	27084
CARA/AED months	1/240	1/74	1/81	1/100

Table 4. CARAs by region, 2007-2011.

	Urban	Rural	Mixed	Totals
CARAs	38 (14%)	126 (46.3%)	108 (39.7%)	272
Shockable (n=263)	22/36 (61.1%)	68/123 (55.3%)	64/104 (61.5%)	154/263 (58.6%)
ROSCs (n=260)	17/37 (45.9%)	31/121 (25.6%)	34/102 (33.3%)	82/260 (31.5%)
Discharges (n=262)	5/34 (14.7%)	21/123 (17.1%)	23/105 (21.9%)	49/262 (18.7%)
GP clinic / patient's home (n=269)	22/38 (57.9%)	80/123 (65.0%)	71/108 (65.7%)	173/269 (64.3%)
Source of first AED (n=267)	GP	17 (44.7%)	62 (49.2%)	44 (40.7%)
	Ambulance	16 (42.1%)	42 (33.3%)	46 (42.6%)
	Lay	3	22	15
				40 (14.7%)

Figure 1. Enrollment to MERIT

2347 GPs identified in 2006 & invited to indicate interest
(around 2000 centres of practice)

1361 (58%) indicated interest (811 centres of practice)

531 general practices enrolled 2006-2013

495 general practices enrolled 2006-2011 (reported here)

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation
Title and abstract	1	(a) Five year cohort study of cardiac arrest management in general practice in Ireland (b) Abstract included
Introduction		
Background/rationale	2	Out-of-hospital cardiac arrest has a poor survival rate. Available work suggests that general practice is well placed to provide care and that GPs are willing to do so. Little research has been published on the potential contribution of GPs to care for these emergencies.
Objectives	3	This study describes five year data (2007-20011) for GP involvement in Cardiac Arrest with Resuscitation Attempts (CARA) in the community, with a specific focus on the experience of GPs in rural areas.
Methods		
Study design	4	A five-year cohort study of Irish general practices reporting involvement in cardiac arrests with resuscitation attempts.
Setting	5	Between 2006 and 2012, MERIT supported AEDs and immediate care training at general practice sites in urban, rural and mixed areas throughout Ireland; 495 sites participated during the five years 2007-2011 and are included in this study.
Participants	6	(a) Practices in the MERIT network, reporting any cardiac arrest with a resuscitation attempt in which a GP had been involved. (b)
Variables	7	Date, time, location, participants, AED(s) available, clinical features, rhythms(s) identified, interventions, outcomes on scene, outcomes at 1 week (if known), ambulance response.
Data sources/measurement	8*	MERIT collected data from the 495 sites participating in the five year study period 2007-2011, representing around a quarter of Irish general practices. All Cardiac Arrests with Resuscitation Attempts (CARAs) involving these GPs are identified by quarterly survey; clinical and ECG data are collated with a mean response rate of 89% (81-97%) over the five year period.
Bias	9	Structured debrief by research nurse; all ECG data is downloaded electronically from any MERIT AED used in the incident, printed and returned to the GP and used in the debrief.
Study size	10	Observational study of all cases, involving GPs from participating practices.
Quantitative variables	11	Standard clinical, organisational and outcomes items, used in resuscitation research.
Statistical methods	12	(a) PASW18 used for descriptive data and to calculate Odds Ratios (b) n/a (c) In 10 cases, survival to discharge could not be established. The altered denominators are reported in the relevant tables. (d) n/a (e) n/a
Results		
Participants	13*	(a) Participating GPs identified all cardiac arrests in which a resuscitation attempt occurred. (b) Response rates to quarterly data collection reported. (c) n/a

Descriptive data	14*	(a) Age, gender, location reported. Data reported for each year (2007-2011) and for urban, rural and mixed areas.
		(b) Discharge data missing for 10 patients, denominator amended. These data are missing because individual collapsed patients are not always known to the GP involved and may not be identifiable at follow-up.
		(c) Discharge alive from hospital
Outcome data	15*	Return of Spontaneous Circulation (ROSC) and survival to discharge from hospital.
Main results	16	ROSC and discharge rates reported. Odds ratios indicate survival in rural/mixed areas combined no different to survival in urban areas.
		Data for urban, rural, mixed areas reported in detail.
		Incidence rates per months of AED availability reported
Other analyses	17	n/a
Discussion		
Key results	18	Overall survival compares well with relevant literature. Little data from general practice for comparison. General practice contributes significantly to cardiac arrest management and has significant impact in rural and mixed areas.
Limitations	19	Cases may not be reported by participating GPs and retrospective semi-structured interview follow-up is subject to memory bias.
Interpretation	20	GPs may play a significant role in cardiac arrest management in the community.
Generalisability	21	The results relate to similar health systems with widely available primary care practitioners.
Other information		
Funding	22	Funding sources were the Health Service Executive (HSE), Pre-Hospital Emergency Care Council, Health Research Board and individual Health Boards prior to the the full establishment of the HSE.

*Give information separately for exposed and unexposed groups.